Aspirating Systems
Rail Cars

System Sensor Application Design Guide

Preface

System Sensor has produced this Design Guide as a reference, to be consulted when designing and specifying System Sensor fire protection solutions on board Rail Cars. It outlines the unique risks and detection issues involved, with suggestions on how to manage both. The fact that evacuation is difficult, makes the very early detection of smoke essential to passenger safety. High air movement and high concentrations of airborne particles, within the Rail Car environment, present a challenge to most conventional detection technologies.

In this Design Guide, we will discuss the relevant design considerations and make recommendations regarding the most effective way in which to install a System Sensor solution in the particular Rail Car for which the system is being designed. System Sensor detectors can be used to protect standard passenger carriages, buffet cars, sleepers and luggage compartments.

Important Note: The information contained in this Design Guide should be used in conjunction with specific local fire codes and standards. Other regional industry practices, where applicable, should also be adhered to.

Contents

1. Background Information

1.1 Fire Safety Considerations in Rail Cars

The major fire risks and detection difficulties within Rail Cars arise as a result of the following:

- Concealed electrical and mechanical equipment in ducts, cabinets and ceiling voids may delay the detection of fires originating in these areas, especially where conventional detection devices are located outside these areas.
- Insufficient maintenance of electrical equipment increases the risk of electrical fires.
- Heating, Ventilation and Air Conditioning (HVAC) systems may cause fire events since they contain moving mechanical components and heating elements.
- Unsupervised electrical faults, involving large currents, provide a significant ignition source.
- Unauthorized smoking, which usually takes place in the toilets where it is less likely to be discovered.
- Arson.
- Conventional detector failures due to the buildup of soot deposits from diesel fumes, brake dust and other contaminants such as lint (from upholstery, carpets, clothing etc) or vandalism. Airborne pollution gradually blocks the conventional detectors' mesh covers, lessening their sensitivity. Often these failures go unnoticed due to a lack of detector self diagnostics and infrequent maintenance.
- High air movement, caused by the HVAC system, dilutes the smoke. This makes its detection more difficult and the identification of the fire source location more complex.
- Rapid growth and spread of fire is promoted by the presence of a significant (high density) fuel load. This fuel is either permanently on board, in the form of upholstery, or is brought on board by passengers, in the form of luggage or discarded rubbish such as newspapers and food wrappers; the latter being unregulated and highly combustible.
- Response to a fire incident is often delayed due to the limited number of staff on board. Passengers, unassisted, cannot be expected to handle an emergency situation effectively.

1.2 Performance-Based Design

The unique environments within Rail Cars present a challenge to both early and reliable fire detection. There is a high likelihood that detection system performance will be dependent on the level of pollution, air change rate, location of the fire event etc. The flexibility of Performance-Based Design, while still following rigorous engineering processes, allows the fire protection system to be tailored to the specific requirements of each individual application's environment, with the commercial drivers to manage the risks.

Detector spacing or, for a System Sensor pipe, sample hole spacing is traditionally dictated by local prescriptive codes and standards. However, there are very few codes governing fire protection aboard Rail Cars; the inclusion and design of fire protection systems being largely at the discretion of the rail operator or Rail Car manufacturer. In a more performance-based approach, each installation is assessed according to its specific environmental conditions. Sample hole spacing and location can then be altered easily to suit the particular performance requirements of each individual Rail Car.

Most codes relating to Rail Cars are limited to the design of the vehicle, the fire resistance of materials used, the inclusion of fire barriers, electrical wiring requirements, isolation of high risk equipment etc. The new European Draft Standard, PRENV 45545, Railway Applications – Fire Protection on Railway Vehicles[1], takes the lead in prescribing good practice and contains many recommendations regarding fire protection within Rail Cars.

Regardless of whether codes require a risk assessment (as is often the case), dictate minimum requirements or where the inclusion and design of fire protection systems is left to the discretion of the rail operator or Rail Car manufacturer, Performance-Based Design concepts can be used to achieve the best balance between performance, reliability, flexibility of design and cost.

Standard risk management concepts, like those listed below, can also be used to assess the area to be protected:

- AS/NZ 4360 Risk Management Standard[2].
- SFPE Handbook of Fire Protection Engineering Third Edition4[3].

While this alternative fire protection solution can be made to comply with local and national codes and standards, for life safety, assessment of the environmental risks and performance requirements, specific to the particular Rail Car, are also conducted as part of the design process.

1.3 Key Design Considerations

The following should be considered when designing a System Sensor system for a Rail Car:

1. What are the Rail Cars to be used for (passenger transport, long or short haul, buffet, sleeper, luggage etc)?
2. What is the layout of the Rail Car and where are the System Sensor detectors and sampling pipe networks best located (in equipment/utility cabinets, in HVAC systems, in toilets, on carriage ceiling or under luggage racks)?
3. What aspects of the Rail Car design may affect the normal movement of smoke? For example, are there inter-car doors and if so, when are they open and closed?
4. How will the sampling pipe network integrity (with respect to being air-tight) be maintained?
5. How can detectors and sampling pipes be concealed to protect them from vandalism?
6. What is the anticipated life of the Rail Car and when are the services (e.g. HVAC) and interior to be refurbished?
7. Where are the Supply and Return Air vents located? Is cigarette smoking tolerated and, if so, in which areas?
8. What is the expected background pollution level within the Rail Car during normal service?
9. If a diesel engine, which of the Rail Cars will be closest to the engine (highest pollution levels), and which will be furthest away (lowest pollution levels)?
10. Should the presence of pre-alarms or Fire alarms trigger any automatic smoke management (e.g. HVAC shutdown) or fire control systems?
11. Is fire suppression to be included in the fire protection system?
12. What system control should be available to staff, under what circumstances should control be permitted and how will access be managed?
13. Will inter-car doors be closed in the event of a fire?
14. What is the policy on the opening of Rail Car doors in the event of a fire?
15. How can the system be designed for the best addressability?
16. How are System Sensor pre-alarms and Fire alarms to be reported and dealt with?
17. What staff and passenger fire response procedures will be needed and what system requirements would facilitate these procedures?
18. What level of competence or training is to be assumed for staff and passengers?
19. What level of maintenance will be required to counteract the high concentration of particulate matter in the air in some of the cars (e.g. sampling pipe cleaning, filter replacement etc)?
20. What recommendations or requirements, if any, do local codes and standards make?
21. Are there any other relevant industry or manufacturer-specific practices which must be adhered to, if so, what other Rail Car design features or factors must be considered?

1.4 Why Use System Sensor Smoke Detection?

It is essential that fire events in Rail Cars be detected as early as possible to avoid asset damage, service disruption and associated penalties. Most importantly, early detection ensures passenger safety.

The limitations of conventional point (spot) type smoke and heat detectors must be considered. In a Rail Car, smoke and heat tend to follow the air streams created by the HVAC system with the following consequences:

- Smoke dilution caused by air movement and the introduction of clean air during the air conditioning cycle, decreases the likelihood of the alarm threshold of point (spot) type smoke detectors being reached and will, as a minimum, delay the reporting of a fire event.
- Air conditioning operation will cool the smoke plume allowing its temperature to drop below the activation threshold of heat detectors.
- Point (spot) type smoke detector performance is affected by the direction and magnitude of airflows in their vicinity. Consequently, point (spot) type smoke detector performance will vary under the different airflow conditions caused by changes in the operating capacity of the HVAC system.

The performance reliability of conventional point (spot) type detectors is further compromised by the relatively high concentration of dust and lint present within Rail Cars. Deposits from diesel soot and brake dust contaminate the unprotected optical surfaces of conventional point (spot) type smoke detectors, eventually rendering them inoperable. Lint and other materials may also become trapped in the protective mesh cage around them, gradually impeding the entry of smoke into the sensing chamber. This increased impedance to air flow is not monitored by these passive devices and, if not regularly maintained, may lead to unreported fire events. The regular maintenance of point (spot) type detectors, to overcome these issues, could become an expensive exercise.

The very early warning smoke detection capability of the System Sensor system combats the detection difficulties in the following ways:

- The System Sensor system detects fires early, at the incipient stage. This means that smoldering electrical fires and slow developing flaming fires will be quickly detected, providing staff with an opportunity to investigate and take action.
- Early warning also helps avoid costly delays and allows time for making crucial evacuation decisions. For example, the train can be moved out of tunnels or on to sections of track not immediately needed by other rail traffic.
- The cumulative effect of System Sensor sampling overcomes issues associated with smoke dilution. By positioning the System Sensor pipe network correctly, smoke will be collected by several sampling holes at different locations within the protected area.
- The System Sensor system is able to reliably detect smoke in a fast moving stream of air. This facilitates sampling within the HVAC system, towards which the majority of smoke quickly migrates.
- A System Sensor system actively draws air through its sampling holes, which ensures a consistent detection performance in varying airflow conditions.
- Where Rail Cars are open gangway, without doors separating each carriage, smoke is likely to disperse more quickly and be more difficult to detect. The System Sensor system copes well in this type of environment, where there is high air movement and smoke dilution.
- The alarm thresholds and time delays on a System Sensor system can be set to account for dusty or polluted environments, thereby reducing the incidence of false alarms.
- Its very early warning capability means that the System Sensor system, with Performance-Based Design, could overcome some of the more stringent regulations governing the use of flammable materials in Rail Cars.
- The clean air bleed used by System Sensor detectors, serves to protect its optical surfaces from the effects of pollution, thereby, maintaining the detectors sensitivity and performance.
- In cases where a fire suppression system is present, System Sensor detectors can be configured to activate suppressant release.
- A complete System Sensor portfolio comprises fault tolerant communications networking, annunciation and control solutions, involving System Sensor System Manager (VSM) and System Sensor remote displays.
- System Sensor detectors support a number of open communication interfaces that allow more sophisticated integration with local and remote annunciation and control systems.
- System Sensor systems can be designed to reduce the chance of accidental destruction, vandalism or tampering. The detectors can be positioned out of sight, anywhere in the Rail Car, with their sampling pipes concealed above a false ceiling or made to look like part of the luggage racks. Installation of a System Sensor detector and sampling pipe network, within the HVAC system, offers a totally ‘invisible’ solution.
- Unlike point (spot) type detectors, System Sensor detectors in operation continuously perform self-diagnostics and report any faults that may occur.

1.5 Risk Analysis in Design

A risk analysis should be performed to establish the most appropriate fire response processes for the particular train, including a review of all items listed in Section 2.1.

The processes should address the following required actions in the event of a fire:

1. Staff response on issue of a pre-alarm, including how to determine and verify the location(s) of the detector(s) issuing the pre-alarm(s), how to alert other staff and methods for investigation of the situation.
2. Staff response on issue of a ***Fire*** alarm, including how to determine and verify the location(s) of the detector(s) issuing the alarm(s), how to alert other staff and passengers, how to extinguish the fire(s) and/or coordinate evacuation.
3. Procedures to be followed after a ***Fire*** alarm such as how to clear the area of smoke using the HVAC system, reset the detectors and re-commission the system after a major fire event.

2. Designing For Effective Fire Protection

2.1 Levels Of Protection

For the purposes of designing a System Sensor system, a Rail Car can be divided into a number of areas; not all areas being relevant to every Rail Car. These areas are shown in Table 1.

Table 1 – Areas within a Rail Car

Area	Details
Passenger	• Passenger Compartments (e.g. buffet car) • Passenger saloons (i.e. carriages containing seating) • Corridors, Vestibules and other small areas • Sleeper Compartments • Toilets
Technical	• Technical Equipment Cabinets • HVAC Systems • Combustion Engines Inside/Under the Rail Car (Diesel Locomotives) • Electric Traction Equipment Inside/Under the Rail Car (Electric Trains) • Engine Compartment on Locomotives
Staff	• Luggage Compartments • Cooking or Catering Areas • Driver Cabs • Other Staff Areas (e.g. Guard’s Area).

The table below summarizes the European Draft Standard PRENV 45545[1], which provides recommendations on which of these areas require automatic fire detection, local alarms (at detector) and remote alarms (in staff area or Central Monitoring Station).

Table 2 – Recommendation on which areas, if applicable, within Rail Cars require fire detection and fire alarm notification according to Standard PRENV 45545.

Rail Car Area	Automatic Detection	Local Alarm Notification	Remote Alarm Notification
Passenger Compartments	✓		✓
Passenger Saloons	✓		✓
Corridors, Vestibules and other Small Areas	✓		✓
Sleeper Compartments	✓	✓	✓
Toilets	✓		✓
Technical Cabinets			✓
HVAC System	✓		✓
Inside/Under Car Combustion Engines	✓		✓
Inside/Under Car Electric Traction Equipment	✓		✓
Engine Compartment on Locomotives	✓		✓
Luggage Compartments	✓		
Cooking or catering Areas			✓
Driver Cabs			✓
Other Staff Areas			✓

Note: Local alarms are those issued directly by the detectors in the vicinity of the fire event. Remote alarms are sent, by the detector, to a central control area such as the driver's cab or guard's area.

Important Note: The recommendations in this Table are very general; there will be instances where protection is optional in areas designated as being recommended and vice versa. Exceptions depend on the type of Rail Car and its design.

2.2 On Ceiling Protection

System Sensor sampling pipes can be run along the ceiling of Rail Cars as shown (Figure 1). Both the detector and sampling pipe are concealed to protect them from vandalism and to improve interior aesthetics; the detector could be placed in an equipment/utility cabinet and the sampling pipe in the ceiling void.

Important Note: Since there are no code requirements dictating the number, spacing or diameter of sampling holes on Rail Cars, it is recommended that the PipeIQ Pipe Network Modeling Program be used to assist in the design process.

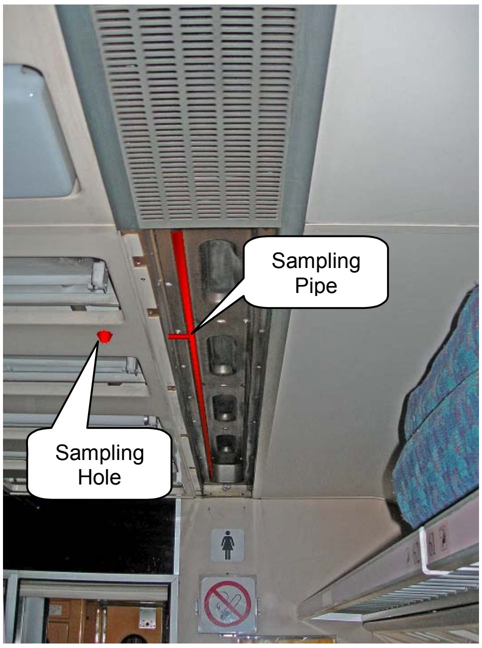

Figure 1 – Example of a System Sensor sampling pipe on the ceiling of a Rail Car.

Where the ceiling void of the Rail Car is difficult to access, sampling pipes can be positioned within or integrated into the structure of the overhead luggage racks as shown (Figure 2).

Figure 2 – Example of System Sensor sampling pipes positioned under the overhead luggage racks in a Rail Car.

Due to the fact that Rail Cars may be swapped between trains, it is advisable to protect each carriage with its own System Sensor detector.

Using a System Sensor detector to cover multiple Rail Cars is not recommended for the following reasons:

- The task of managing the addressing of Rail Cars to an annunciation and reporting system becomes very complex.
- It is difficult to ensure the integrity of the sampling pipe network junctions during a rail car swap and reconnection.

2.3 HVAC Protection

Since air from the entire carriage is cycled through the HVAC system, sampling at the return air plenum ensures thorough carriage coverage. In effect, the HVAC system acts as an air collection and delivery service for the System Sensor detector. HVAC systems are also a recognized fire hazard, due to their mechanical components and heating elements.

A System Sensor detector, with a short sampling pipe, can be placed across the evaporator coil of the HVAC system as shown (Figure 3).

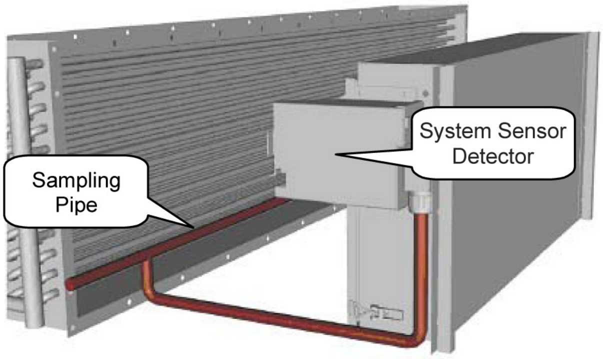

Figure 3 – Example of System Sensor return air plenum sampling in a Rail Car.

Important Note: Sampling points (holes) should be oriented at an angle of 30° to the incoming airflow.

Advantages of HVAC system sampling is that the detector is hidden, aesthetics are improved and the potential for vandalism is reduced. The placement of the sampling pipe behind the return air plenum filter is highly recommended to avoid risks of large airborne debris contaminating the sampling points. Following this recommendation ensures that the HVAC system's filter acts as a pre-filter, removing dust and lint from the sampled air before it reaches the System Sensor detector. However, the performance of the System Sensor system is dependant on the appropriate level of maintenance on the HVAC system's filter (refer to Section 3.1 – "HVAC Filter Life").

HVAC system sampling is most effective when the HVAC system is in operation. Although System Sensor detectors are perfectly capable of detecting smoke without forced ventilation, the system performance under this condition should be tested and taken into consideration.

2.4 In Toilet Protection

Both arson and unauthorized smoking are more likely to occur in the toilets, since there is less chance of discovery. Toilets are normally protected by running a capillary tube into the toilet from the main sampling pipe. This capillary tube can be run from a sampling pipe mounted in the ceiling void or from a sampling pipe on the return air plenum of a HVAC system. A single System Sensor detector can also be used to sample simultaneously from the ceiling, HVAC system and toilet.

Normally, the HVAC system design ensures that the toilets are at a negative static pressure compared with the rest of the passenger and staff areas. This negative pressure will create a differential pressure with the System Sensor detector exhaust and reduce the airflow through the toilet sampling hole.

The reduced airflow through the toilet sampling hole can be counteracted in one of the following ways:

- By ensuring that the toilet sampling hole is closest to the detector.
- By ensuring that the diameter of toilet sampling holes, further away from the detector, are enlarged by 0.5 mm (0.02 in).
- By using Heat Activated Sampling Point (HASP) heads.

HASP heads use wax-sealed plugs to block sampling holes. When the temperature exceeds 65°C (149°F), which will occur quickly in the confines of the toilet, the wax seal melts allowing the plug to drop out and the sampling hole to admit smoke normally. When this occurs, the detector will probably indicate a flow fault just prior to issuing an alarm.

Notes:

- Smoke tests should be conducted in every pressurised protected area and for all operational states of the HVAC system.
- If smoke detection in the toilet is to be used to discourage or expose unauthorized smoking, it would not be appropriate to use HASP heads.

Important Note: PipeIQ calculations must account for the difference in system performance before and after HASP heads have dropped out. It is recommended that two separate PipeIQ designs be generated and that the detector then be configured to account for the different airflows experienced in both situations.

On ceiling protection is used in Buffet Cars with the detector either on the corridor side of the car or in the middle. If in the middle, a branched sampling pipe arrangement may be required. HASP heads can be used in the kitchen to prevent “false” alarms as a result of the higher than normal levels of smoke. Where HASP heads are not used, smoke alarm thresholds should be adjusted upwards to an appropriate value.

2.6 Sleeper Car Protection

In sleeper cars, ceiling protection is employed with a sampling hole in each sleeping compartment as shown (Figure 4).

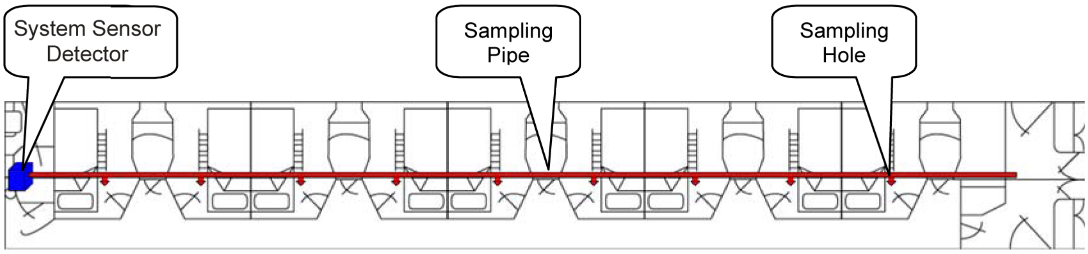

Figure 4 – Example of ceiling protection installed in each Sleeper Compartment.

Note: It is recommended that sampling holes in showers be fitted with HASP heads to prevent condensation entering the pipe network.

2.7 Double-Deck Protection

For optimum addressability, Rail Cars with upper and lower decks can be protected by four System Sensor detectors two on the ceiling of each deck, one in the vestibule and one across the HVAC system return air vent as shown (Figure 5).

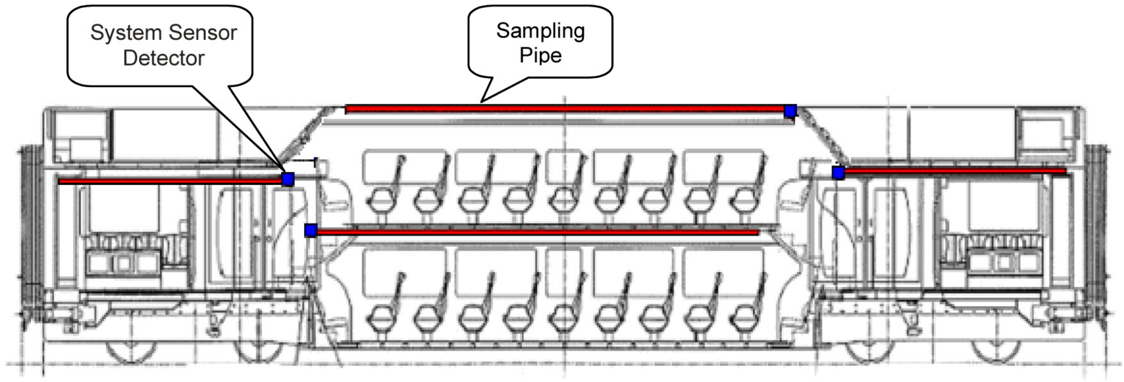

Figure 5 – Example of double deck protection using ceiling and return air sampling.

2.8 Vestibule Protection

Many Rail Cars contain large vestibules that form areas separate from the rest of the open saloons. Like double deck Rail Cars, these vestibules can be protected by HVAC system return air sampling. If on ceiling sampling is used, an extension may be required to each vestibule to ensure adequate sampling

2.9 Luggage Compartment Protection

Luggage compartments can be protected with on ceiling sampling pipes as shown (Figure 6).

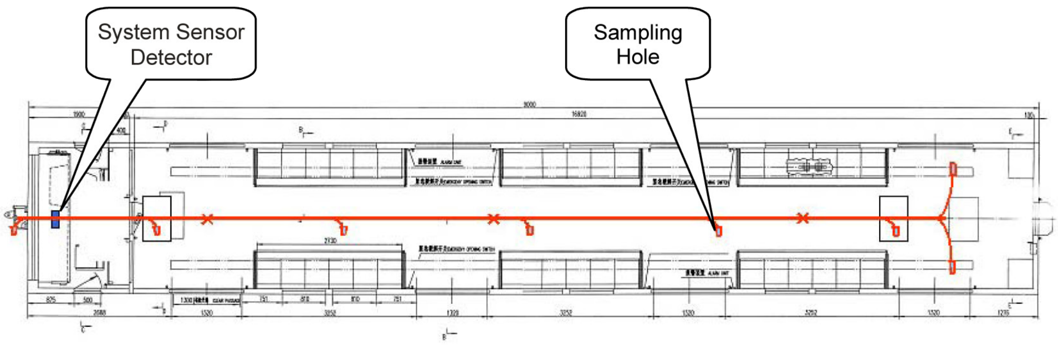

Figure 6 –Top view example of Luggage Compartment protection.

2.10 Electrical Equipment Protection

System Sensor sampling pipes can be placed inside electrical and utility equipment cabinets or within cable ducts, for individual equipment protection

System Sensor detectors can also be used to protect electrical wiring in ducts and other small spaces with pipe branches or capillary tubes as shown (Figure 7).

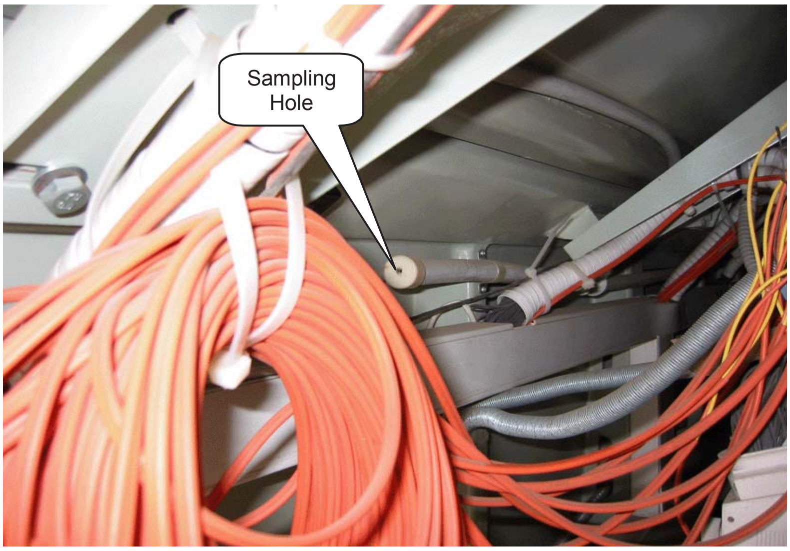

Figure 7 – Example of electrical wiring protection.

2.11 Locomotive Protection

Locomotives contain both large mechanical and high current electrical systems which generate significant amounts of heat and present a fire hazard as ignition sources. System Sensor detectors can be used to protect electric and diesel locomotives as shown (Figure 8).

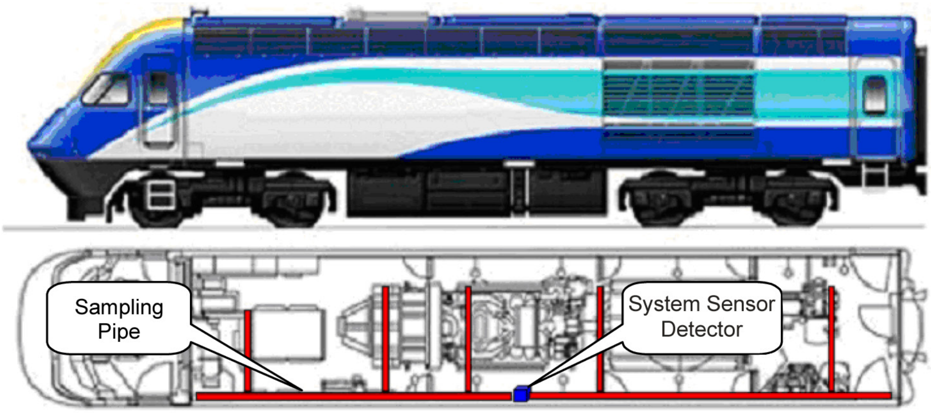

Figure 8 – Example of locomotive protection.

Due to the high background pollution levels, caused by diesel soot and brake dust, the System Sensor detector alarm thresholds will need to be set accordingly. It may also be prudent to install an in-line filter (in accordance with System Sensor recommendations) to remove as much large particulate matter as possible before the sampled air enters the detector. Targeted sampling of high-risk equipment should also be considered.

The driver's cab could also be protected by a separate detector, either through the dedicated driver's HVAC system, or by an extension of the pipe network protecting the locomotive.

3. Other Design Considerations

3.1 HVAC Filter Life

Where sampling at the return air plenum is the primary protection method, there are several filter issues that must be considered.

The HVAC system return air filter will increasingly attenuate smoke over time as it becomes loaded. Filter 'efficiency' (rate of removal of particulates, including smoke) gradually improves until just prior to the filter becoming completely blocked, at which point there is a rapid increase in smoke attenuation. The HVAC system return air filter must be changed, before the high performance of the System Sensor detectors becomes compromised.

The rate at which smoke attenuation is increasing must be evaluated in order to determine how often HVAC filters will require replacement. Generally, HVAC system filters promote passenger comfort, and consequently are well maintained.

Once the HVAC system return air filter replacement method or frequency has been established, a strict policy to ensure that this replacement occurs on time must be implemented since this filter forms part of the fire protection system.

3.2 Sampling Pipe Material And Mounting

An appropriate fire hazard analysis should be conducted to determine the most suitable System Sensor sampling pipe material and fittings. The following fire performance criteria should be considered:

- Ignitability
- Fire spread
- Smoke production

System Sensor recommends the use of HFT (Halogen Free, Fire Resistance, Temperature stability) or metallic (copper, stainless steel) sampling pipes.

Sampling pipe penetrations must not be designed in a manner that allows them to act as passageways for fire and smoke.

The continual vibration experienced by System Sensor sampling pipes on board Rail Cars can, in rare circumstances, lead to pipe disconnections or other pipe damage. Depending upon the application, it may be necessary to protect sampling pipes with rubber shock absorbers placed between the sampling pipe and pipe mountings.

3.3 Detector Mounting

System Sensor detectors should be mounted on a rubber surface such that the shock absorber is inserted between the mounting bracket and the wall of the Rail Car.

3.4 Concealing Detectors And Sampling Pipe Networks

System Sensor detectors can be protected from tampering or vandalism by mounting them inside equipment/utility cabinets.

Ceiling mounted sampling holes can be concealed from the public behind a metal mesh without impairing their function (Figure 9). This mesh looks like part of a modern ceiling design so will not attract attention or arouse suspicion.

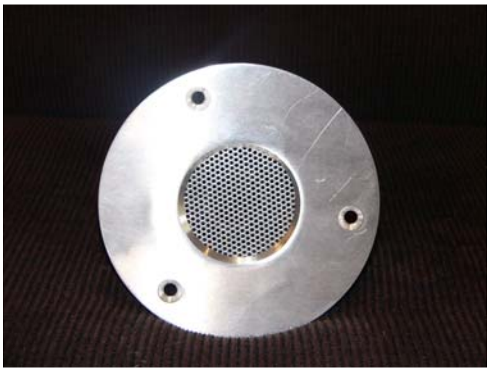

Figure 9 – Example of a mesh cover to protect sampling pipes against vandalism.

3.5 Addressability

It is very difficult to achieve addressability within a Rail Car where air movement is prominent during the operation of the HVAC system. Addressability is limited to the Rail Car of fire origin.

Addressability in double-deck Rail Cars is ensured with multiple System Sensor detectors.

In the case where inter-car doors are kept open, it is anticipated that smoke from a fire event in one carriage will spread to other carriages. System Sensor system reliable and early warning detection will provide alarm signals from the smoke affected carriages, indicating within which a fire event is underway.

3.6 System Sensor Detector Signaling

Communication with the Train Management System (TMS) or Train Operating System (TOS) can be achieved in two ways :

- Via a serial data connection.
- Via relays.

1. Interfacing via Serial Data Communications

Using serial data communications with System Sensor detectors, allows a great deal of flexibility and control during the life of the Rail Car. With this type of connection the following is possible:

- Testing of fire system performance during design validation.
- Testing of all circuits during installation.
- Testing of the fire system operation during detector commissioning.
- Detector alarm/fault status and information, as well as smoke obscuration, reporting during operation.
- Detector maintenance and troubleshooting can be conducted.

Investigation of any alarms or trouble events indicated by the local annunciation or via relay outputs, where present, can be conducted via serial data interfaces. Examples of this type of investigation include enquiries about the real-time status of detectors and reviews of detector event logs. The serial data communications port can also facilitate remedial actions such as clearing latched alarms and running various detector commands, both locally and remotely, during service and operation. Serial data communications also allow System Sensor detectors to be interfaced to other devices aboard the train.

System Sensor System Sensor monitoring software, could be used to provide graphical fire status information and a common interface for efficient investigation and event control. The same system could also be used for more complex commissioning and maintenance activities.

For simple interfaces with the HVAC system, the RS232 serial data port of the System Sensor detector may be interfaced with the PLC/controller of the HVAC system, which then acts as the approved interface to the TOS.

2. Interfacing via Relays

Using relays allows the simplest communication interfaces to a wide range of annunciation and monitoring systems. Most TOS support interfaces to dry-contact relays. However, there are some drawbacks to using this method as outlined below:

- Long lengths of cable may be required.
- The amount of control possible and status data is limited.

4. Ongoing Considerations

4.1 System Commissioning

After the System Sensor system has been installed on each Rail Car, it must be commissioned prior to release for service. The commissioning procedure will verify system performance and sampling pipe network integrity with PipeIQ results.

The process of commissioning should follow standard System Sensor practices as described in the System Sensor System Design Manual[4].

4.2 Performance Tests

The System Sensor system design must be validated by real smoke tests, performed on a representative model of the train (Figure 10). These tests must encompass all relevant operational modes (stationary/mobile, doors open/closed and HVAC system (on/off, heating/cooling, fresh-air dampers open/closed etc)). The purpose of these smoke tests is to validate the system performance for both pre-alarm and ***Fire*** alarm activation, including suppression if applicable.

Figure 10 – Example of a performance test (paper smoke test) on a passenger car.

4.3 Service and Maintenance

The System Sensor system shall be serviced and maintained according to both local codes and standards and the instructions provided in the Maintenance section of the System Sensor System Design Manual[4].

Important Note: Due to the excessive amount of dust and lint within certain Rail Cars, an appropriate System Sensor filter replacement program needs to be put in place.

A biannual maintenance schedule, including the following, is also recommended:

1. Visually inspect the sampling pipes and sampling holes. If they appear dirty, clean them with an industrial vacuum cleaner. Make sure the sampling pipes are disconnected from the System Sensor detectors and the system is in standby mode before cleaning the sampling pipes.
2. Perform a system test including fault and fire tests to check the Trouble and Alarm circuits for the detector as well as the connectivity to the System Control and Indicator Panel.

References

[1] European Standard PRENV 45545 (2000) *Railway Applications – Fire Protection on Railway Vehicles – Part 6 Fire Control and Management Systems.*

[2] Australian Standard AS/NZ 4360 (1999) *Risk Management Standard.*

[3] SFPE (2002) Handbook of Fire Protection Engineering, 3rd Edition.

[4] System Sensor (2006) *System Sensor System Design Manual,* Ed. 4.5.

Disclaimer On The Provision Of General System Design Recommendations

Any recommendation on system design provided by System Sensor is an indication only of what is considered to be the most suitable solution to meet the needs of the common application environments described.

In some cases the recommendations on system design provided may not suit the unique set of conditions experienced in a particular application environment. System Sensor has made no inquiry nor undertaken any due diligence that any of the recommendations supplied will meet any particular application. System Sensor makes no warranty as to the suitability or performance of any recommendation on system design. System Sensor has not assessed the recommendation on system design for compliance with any codes or standards that may apply nor have any tests been conducted to assess the appropriateness of any recommendations on system design. Any person or organization accessing or using a recommendation on system design should, at its own cost and expense, procure that the recommendation on system design complies in all respects with the provision of all legislation, acts of government, regulations, rules and by-laws for the time being in force and all orders or directions which may be made or given by any statutory or any other competent authority in respect of or affecting the recommendation on system design in any jurisdiction in which it may be implemented.

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Installation information: in order to ensure full functionality, refer to the installation instructions as supplied.